

USER INTERFACE SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. application Ser. No. 12/319,334 filed on 5 Jan. 2009 and entitled "User Interface System" (known internally as TACT-P02), which is incorporated in its entirety by this reference.

[0002] This application also claims the benefit of U.S. Provisional Application No. 61/223,002 filed 3 Jul. 2009, which is incorporated in its entirety by this reference.

BRIEF DESCRIPTION OF THE FIGURES

[0003] FIG. 1 is a top view of the user interface system of a preferred embodiment;

[0004] FIG. 2 is a cross-sectional view illustrating the operation of a button array in accordance to the preferred embodiments;

[0005] FIGS. 3a, 3b, and 3c are cross-sectional views of the retracted, extended, and user input modes of the preferred embodiments, respectively;

[0006] FIGS. 4a and 4b, 5a and 5b, and 6a and 6b are top and cross-sectional views of the circular, rectangular, and ring arrangements, respectively, of the attachment points of the preferred embodiment;

[0007] FIGS. 7a and 7b are cross-sectional views of the retracted and extended states, respectively, of the first variation of the first preferred embodiment;

[0008] FIGS. 8a and 8b are cross-sectional views of the retracted and extended states, respectively, of the second variation of the first preferred embodiment;

[0009] FIGS. 9a and 9b are cross-sectional views of the retracted and extended states, respectively, of the third variation of the first preferred embodiment;

[0010] FIGS. 10a and 10b, 11a and 11b, and 12a and 12b are cross-sectional views of the retracted and extended states of the first variation of the second preferred embodiment with thin regions at the attachment point, thin regions closer to the center of the cavity than the attachment point, and with multiple thin regions, respectively;

[0011] FIGS. 13a and 13b are cross sectional views of the fully expanded and user actuated states, respectively, of the particular region;

[0012] FIGS. 14a and 14b are cross-sectional views of the second variation of the second preferred embodiment with a pocket within the layer in the retracted and extended state, and

[0013] FIGS. 15a and 15b are cross-sectional and top views, respectively, of the second variation of the second preferred embodiment with a pocket through the thickness of the layer;

[0014] FIGS. 16a and 16b are cross-sectional views of the third variation of the second preferred embodiment in the retracted and extended states, respectively;

[0015] FIGS. 17a and 17b are cross-sectional views of the first variation of the third preferred embodiment in the retracted and extended states, respectively;

[0016] FIGS. 18a and 18b are cross-sectional views of the second variation of the third preferred embodiment in the retracted and extended states, respectively; and

[0017] FIGS. 19 and 20 are top views of examples of the second variation of the third preferred embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] The following description of the preferred embodiments of the invention is not intended to limit the invention to these preferred embodiments, but rather to enable any person skilled in the art to make and use this invention.

[0019] As shown in FIGS. 1 and 2, the user interface system 100 of the preferred embodiment includes: a layer 110 defining a surface 115, a substrate 120 supporting the layer 110 and at least partially defining a cavity 125, a displacement device 130 coupled to the cavity 125 and adapted to expand the cavity 125 thereby deforming a particular region 113 of the surface 115, and a touch sensor 140 that detects inputs from the user. The perimeter of the particular region 113 is at least partially defined by one or more attachment points 112. The user interface system 100 may also include a display 150 coupled to the bottom surface of the substrate 120 and adapted to output images to the user.

[0020] The user interface system 100 of the preferred embodiments has been specifically designed to be used as the user interface for an electronic device, more preferably in an electronic device that benefits from an adaptive user interface. The electronic device, which may or may not include a display, is preferably an automotive console, a desktop computer, a laptop computer, a tablet computer, a television, a radio, a desk phone, a mobile phone, a PDA, a personal navigation device, a personal media player, a camera, a watch, a remote, a mouse, a trackpad, or a keyboard. The user interface system too may, however, be used as the user interface for any suitable device that interfaces with a user in a tactile and/or visual manner. As shown in FIG. 3, the surface 115 of the user interface system too preferably remains flat until a tactile guidance is to be provided at the location of the particular region 113. The surface 115 of the user interface system 100 may also be deformed when a user input is required. At that time, the displacement device 130 expands the cavity 125 to expand the particular region 113, forming a deformation that may be felt by a user, and providing tactile guidance for the user. The expanded particular region 113 preferably also provides tactile feedback when the user applies force onto the particular region 113 to provide input. However, any other arrangement of the user interface system too suitable to providing tactile guidance and/or detecting user input may be used.

[0021] As shown in FIGS. 3a, 3b and 3c, the cavities 125 of the preferred embodiment functions to hold a fluid and to have at least two volumetric settings: a retracted volume setting (shown in FIG. 3a) and an expanded volume setting (shown in FIG. 3b), both of which are actuated by the displacement device 130. When in the expanded volume setting, the user may inwardly deform (or "actuate") the particular region 113 to provide a user input (shown in FIG. 3c). The fluid is preferably a liquid (such as water, glycerin, or ethylene glycol), but may alternatively be a gas (such as air, nitrogen, or argon) or any other substance (such as a gel or aerogel) that expands the cavity 125 and deforms the surface 115. In the expanded volume setting, the cavity 125 expands above the plane of the surface 115, thereby deforming a particular region of the surface 115. The deformation of the particular region 113 functions to provide tactile guidance and/or tactile feedback on the surface 115 for the user. The deformation of